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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
B04B 11/02 // B23Q 11/10, F04D 1/14

A1

(11) International Publication Number: WO 00/59639

(43) International Publication Date: 12 October 2000 (12.10.00)

(21) International Application Number: PCT/SE00/00551

(22) International Filing Date: 21 March 2000 (21.03.00)

(30) Priority Data:
9901235-3 7 April 1999 (07.04.99) SE

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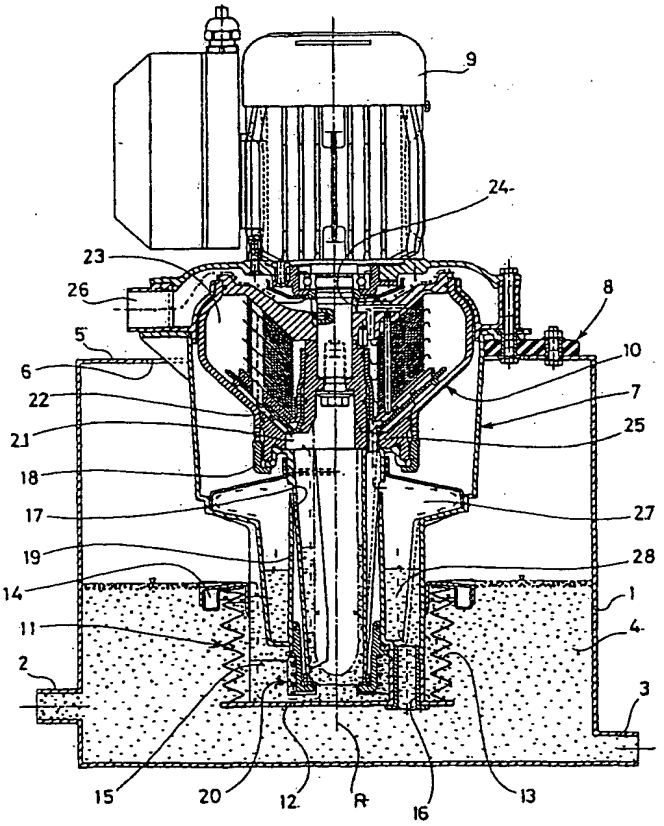
(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KR (Utility model), KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: A METHOD AND A DEVICE FOR SEPARATION OF A SURFACE LAYER OF A LIQUID BODY

(57) Abstract

Upon cleaning of a relatively heavy liquid from small amounts of relatively light liquid the liquids are first introduced into a container (1), in which the light liquid is allowed to collect on the surface of the heavy liquid. Then a surface layer of the liquid body (4) in the container (1), constituting a mixture of the two liquids, is brought to flow over an overflow outlet member (14) into a collecting chamber (15). From the collecting chamber (15) the liquid mixture is pumped further on to a centrifugal separator, from where cleaned relatively heavy liquid is returned to the container (1). According to the invention the liquid mixture is pumped from the collecting chamber (15) to the centrifugal separator by means of a pumping member (17), which is connected with the rotor (16) of the centrifugal separator and, thus, rotates therewith. Hereby, the cleaning operation in question may be performed by means of a simple and non-expensive device.



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A method and a device for separation of a surface layer of a liquid body

The present invention relates to a method and a device for removing from a liquid body a liquid mixture, which forms a surface layer on the liquid body, and separating this liquid mixture into one relatively light liquid and one relatively heavy liquid.

For instance in workshops with machine tools for turning and cutting of metal pieces there is a need for a method and a device of the aforementioned kind for cleaning of liquids used for cooling purposes in the machine tools. Coolants of this kind normally are water based and they are deteriorated during use by among other things small amounts of oil, such as hydraulic oil and lubricating oil, used for the operation of the machine tools. Oil of this kind causes an unpleasant smelling and makes the coolant unusable in course of time, if it is not separated from the coolant. It is known to clean coolants from oil by means of a centrifugal separator. In practice, this is performed such that a liquid mixture in the form of coolant and undesired oil is allowed to flow from a surface layer of a liquid body, containing the coolant to be cleaned, over an overflow outlet member into a collecting chamber, from where the liquid mixture is pumped by means of a pumping device of one kind or another to the centrifugal separator.

Even in other connections there is a need of a method and a device for freeing a relatively heavy liquid from small amounts of a relatively light liquid. Thus, liquids used for cleaning purposes often must be freed from light floating contaminants, so that the liquid can be used anew.

The object of the present invention is to make possible cleaning of a relatively heavy liquid from small amounts of a relatively light liquid in a

simple and non-expensive way by means of a simple and cheap device. The device should be compact and easily mountable in connection to a container which contains the liquid to be cleaned. Furthermore, the device should be operable automatically, and a desired cleaning effect should be obtainable without need of complicated co-ordination of the operation of the centrifugal separator with the operation of the pumping device required for pumping the liquid to the centrifugal separator.

For achievement of this purpose the invention suggests a method of removing from a liquid body a liquid mixture, which forms a surface layer on the liquid body, and separating this liquid mixture into one relatively light liquid and one relatively heavy liquid, the liquid mixture being first caused to flow, as previously known, from the liquid body over an overflow outlet member into a collecting chamber and then pumped therefrom into a centrifugal separator. The method according to the invention is characterised in that the liquid mixture is pumped from the collecting chamber upwardly and into a rotating centrifugal rotor, forming part of the centrifugal separator, by means of a pumping member that is connected with the centrifugal rotor and is rotating therewith and extends down into the liquid mixture in the collecting chamber. Preferably, said overflow outlet member is vertically movable relative to said pumping member, further liquid mixture being caused to flow over from the liquid body to the collecting container in an amount per unit of time corresponding to the capacity of the pumping member and/or the corresponding centrifugal rotor.

For achieving a desired function of the vertically movable overflow outlet member a previously known technique may be used. Thus, the overflow outlet member may be kept floating on said liquid body, in accordance with US-A-3,633,749, or be kept floating on the liquid mixture present in

said collecting chamber, in accordance with US-A-5,693,218. Also a different technology may come into question for automatic control of the amount of liquid mixture that is to flow over from the surface layer of the liquid body to the collecting chamber. A basic mission for the overflow outlet member is to adapt the flow of new liquid mixture into the collecting chamber to the flow of liquid mixture pumped up from the collecting chamber to the centrifugal rotor by means of the pumping device.

If the level of the surface layer of the liquid body is changed, it is desirable that the overflow outlet member automatically adapts itself thereto. This requires, if the collecting chamber is delimited by a collecting container having certain vertically immobile parts, that at least part of one wall of the collecting container is vertically movable together with the overflow outlet member.

In a preferred embodiment of the invention a collecting container wall part of this kind includes a bellows but, alternatively, sealing devices of different kinds may be used between the overflow outlet member and vertically immobile parts of the collecting container.

For cleaning of a liquid mixture, which has been transferred in the above described manner from the surface layer of a liquid body to a collection container for further transportation to a centrifugal separator, it is suggested according to the invention that the centrifugal separator includes a centrifugal rotor, which is connected with a pumping device adapted to extend from above and downwards into liquid mixture present in the collecting container, that the centrifugal separator further includes a driving device, which is adapted to drive the centrifugal rotor as well as the pumping device connected therewith and that the pumping device is adapted to pump liquid mixture to and into the centrifugal rotor.

Said pumping device may be designed in many different ways. Preferably, it includes a pumping member which is directly connected with the centrifugal rotor so that the common driving device may be adapted for rotation of both the centrifugal rotor and the pumping member through one and the same transmission device. However, this is not absolutely necessary according to the invention. Alternatively, the driving device may be coupled separately to the pumping member, in which case a gear device of one kind or another may be used between the driving device and one of the centrifugal rotor and the pumping member. Most important is that an increased rotational speed of the pumping member, meaning an increased liquid flow to the centrifugal rotor, brings with it a corresponding increase of the separation capability of the centrifugal rotor as a consequence of an increased rotational speed thereof.

In a preferred embodiment of the invention a pumping device includes a tubular pumping member, which is rotatable around a substantially vertical rotational axis and which has a central pumping channel for conducting liquid mixture from the collection container to the centrifugal rotor. Preferably, both the centrifugal rotor and the pumping member are rotatable around said vertical rotational axis, and in the preferred embodiment the pumping member, as mentioned, is directly connected with the centrifugal rotor for rotation together therewith. A pumping device of this kind is very gentle to the pumped liquid, i.e. it has a capability of pumping liquid without subjecting it to extremely large sharing forces. Sharing forces of this kind are disadvantageous in this connection, since they cause undesired formation of emulsion of the two liquids to be separated from each other in the centrifugal separator.

The method and the device according to the invention may be used for continuous cleaning of a liquid, cleaned liquid being returned directly to

said liquid body. The cleaned liquid is preferably returned to a level below the predetermined surface layer of the liquid body, so that the pre-separation having occurred in the liquid body is disturbed as little as possible. In the device according to the invention the returning is made by means of a stationary casing, which surrounds the centrifugal rotor and which has a returning member extending down into the liquid body to said level.

As mentioned, the rotatable pumping member extending down into the liquid to be cleaned is preferably tubular. For minimising the wetted surface of the pumping member and/or for avoiding that liquid is pumped upwardly on the outside of the pumping member, this is surrounded according to a further development of the invention by a non-rotatable wall adapted to extend from above and down into the liquid mixture, which during operation of the device is present in the collecting container, a sealing device being arranged to seal between the non-rotatable wall and the rotatable pumping member. The sealing device may have any suitable design. For instance, an annular so called lip gasket of rubber or some other elastic material may be supported by the non-rotatable wall and surround the pumping member and seal radially against the outside thereof. Alternatively, a similar annular lip gasket may be supported by the rotatable pumping member, so that by means of the centrifugal force it may be kept pressed radially outwardly against the surrounding non-rotatable wall.

In a preferred embodiment of the invention the sealing device includes an annular axially movable sealing member and means adapted to accomplish an axial sealing force between the non-rotatable wall or non-rotatable members connected therewith and the rotatable pumping member. The sealing member may be rotatable together with the pumping member, but preferably it is non-rotatable and adapted to be pressed axially against a

sealing surface, preferably an end surface of the rotatable pumping member.

A non-rotatable wall of the aforementioned kind, which surrounds the pumping member, protects against unintentional contacts with the pumping member during rotation thereof.

If the centrifugal rotor is suspended from a flexible suspension device, said non-rotatable wall is preferably suspended from the same flexible suspension device for avoidance of relative pendulum movements between the rotatable and non-rotatable sealing surfaces of the sealing device during operation of the centrifugal rotor.

The invention is described in the following with reference to the accompanying drawing, in which

Figure 1 illustrates a separation device according to the invention, mounted on a container containing liquid to be treated in the separation device,

Figure 2 illustrates the same separation device as figure 1 but with certain parts thereof shown in section,

Figure 3 shows part of the separation device in figure 2 in an enlarged scale, and

Figures 4 and 5 show sections along the lines A-A and B-B, respectively, in figure 3.

Figures 1 and 2 show a container 1 containing liquid, which may be

intended for use as a coolant in machine tools for turning or cutting of metal pieces. Liquid of this kind may be water based, and it is deteriorated upon use by small amounts of oil. Used coolant is intended to enter the container 1 through an inlet 2 and cleaned coolant is intended to leave the container through an outlet 3 to be reused for cooling of pieces. While the coolant is present in the container 1 it forms a liquid body 4, in which said deteriorating oil is collected in a thin surface layer at the top of the liquid body 4.

The container 1 has a horizontal upper limiting wall 5 having an opening 6, through which a separation device according to the invention extends from above and down into the container. The separation device, which forms a self sustaining unit mounted onto the container 1, includes a casing 7, which is suspended from the upper limiting wall 5 of the container through a flexible suspension device 8. Only one of three alike parts of the suspension device 8 is shown in the drawing. Furthermore, the separation device includes a motor 9, which is fastened to the upper part of the casing 7, and a centrifugal rotor 10 (Figure 2) suspended from the motor and surrounded by the casing 7. The motor is adapted to drive the centrifugal rotor 10 around a vertical rotational axis R.

The separation device further includes a collecting container 11, which is supported by the casing 7 within the container 1 in a way such that it is surrounded by the liquid body 4. The collecting container 11 includes a bottom plate 12, a surrounding wall in the form of a bellows 13 circular in cross section and fastened at its lower part to the bottom plate 12, and an annular floater 14, which is fastened to the upper part of the bellows 13. The floater 14 is adapted to float on the liquid body 4 and to form an overflow outlet member, over which a surface layer of the liquid body 4 may flow into the collecting container 11. The upper side of the floater has

several radial recesses or grooves, through which the liquid may flow into the collecting container evenly distributed around the whole of the floater. The grooves give to the floater a stability, so that it moves the same extent vertically around the whole of its circumference.

Figure 2 shows that the collecting container 11 delimits a collecting chamber 15 for a liquid mixture entering therein through the overflow outlet member (the floater) 14. The liquid mixture consists mainly of coolant, which is relatively heavy, and a small amount of oil, which is relatively light. Furthermore, figure 2 shows that the bottom plate 12 of the collecting container is supported by a casing 7 by means of a sleeve 16.

At its lower part the centrifugal rotor 10 carries a tubular, slightly conical pumping member 17, which extends down into the collecting chamber 15. The pumping member 17, which is fastened to the centrifugal rotor 10 by means of a lock ring 18, is surrounded by a substantially cylindrical non-rotatable wall 19, which is supported by the casing 7 and extends from an area above the liquid body 4 down into the collecting chamber 15. At its lower part the wall 19 carries a sealing device 20 adapted to seal against the lowermost part of the pumping member 17, so that liquid mixture present in the collecting chamber 15 will not get into contact with the outside of the pumping member 17. The sealing device 20 is described in detail below with reference to figure 3.

The centrifugal rotor 10 may be of a conventional kind and is therefore not described in detail. For a closer description of the centrifugal rotor of a suitable kind reference is made to, for instance, EP 312 233 B1, EP 312 279 B1, WO 96/33021 and WO 96/33022.

The centrifugal rotor 10 has an inlet chamber 21, which through a channel

22 communicates with a separation chamber 23. Furthermore, the centrifugal rotor 10 has a first outlet 24 for a separated relatively light liquid, in this case oil, and a second outlet 25 for a separated relatively heavy liquid, in this case water based coolant. The casing 7 has a first outlet 26 adapted to receive separated oil leaving the centrifugal rotor through its outlet 24 and a second outlet 27 adapted to receive separated coolant leaving the centrifugal rotor through its outlet 25.

Separated oil is conducted through the outlet 26 to some suitable recipient therefore, whereas separated coolant is conducted through spaces in the casing 7 back to the liquid body 4. Thus, the casing 7 is formed so that separated coolant is conducted on the outside of the stationary wall 19, which surrounds the pumping member 17, down to and through the aforementioned sleeve 16. As can be seen from figure 2, there is delimited within the casing 7 a return chamber 28, in which returned cleaned coolant forms a liquid body, the free liquid surface of which during operation of the separation device will be present somewhat above the liquid surface of the liquid body 4.

Figure 3 shows in a larger scale than figure 2 the collecting container 11 and the sealing device 20. As can be seen, the sealing device includes an axially movable sealing member 29. This is adapted by means of a sleeve formed upper part to seal against the inside of the stationary cylindrical wall 19 and by means of an annular lower part to seal against the rotatable pumping member 17. A screw spring 30 resting on wings 31 is adapted to press the sealing member 29 upwards with reference to figure 3 to sealing against the pumping member 17. For this purpose also the pumping member carries at its lowermost part a sealing member 32 rotatable therewith. The sealing members 29 and 32 abut against each other through axially facing sealing surfaces.

Said wings 31 are connected with the bottom plate 12 and are intended, apart from supporting the spring 30, for counteracting rotation of liquid in the collecting container 15 in the area of the lower part of the pumping member 17. As can be seen, at least one of the wings 31 extends all the way up to the inlet opening of the pumping member in the area of the sealing member 32.

Figure 4 shows a section through the pumping member 17 along the line A-A in figure 3. As can be seen, the pumping member 17 has three internal axially and radially extending wings 33 intended for entrainment of liquid in the rotation of the pumping member.

Figure 5 shows a section through the casing 7 along the line B-B in figure 3. As can be seen, even the outside of the casing 7 has three wings 34 extending both radially and axially. The wings 34 have, like the wings 31, a function of counteracting rotation of liquid in the collecting chamber 15.

The separation device according to the invention operates in the following manner:

The floater 14 is formed such that, as long as no liquid is present in the collecting container 11, it may float on the liquid body 4 but only at a level such that a surface layer of the liquid body 4 flows over the floater 14 and into the collecting container 11. When the liquid surface in the collecting container 11 approaches the floater 14, the floater is actuated also by the liquid in the collecting container 11. Then, the floater 14 is lifted up to a level such that it blocks further inflow of liquid into the collecting container 11. This occurs before the liquid surface in the collecting container 11 has reached up to the same level as the liquid surface in the surrounding container 1.

When the motor 9 is started for driving the centrifugal rotor 10 and the pumping member 17 connected therewith around the rotational axis R, liquid is pumped from the collecting container 11 upwardly through the pumping member 17 and into the centrifugal rotor 10. The liquid surface will then sink in the collecting container 11, whereby also the floater 17 will sink somewhat, and new liquid will flow into the collecting container 11 from the surface layer of the liquid body 4. If an even flow of liquid is pumped out of the collecting container 11, the liquid surface therein will be adjusted to a certain level, as can be seen from figures 2 and 3, and the same amount of liquid will flow in via the floater 14 as out through the pumping member 17.

In the pumping member 17 a substantially cylindrical liquid surface will be formed, as is illustrated in figure 2, which extends all the way from the lower part of the pumping member to the inlet chamber 21 of the centrifugal rotor. In the liquid body, which is thus formed in the pumping member 17 and which is entrained in its rotation by the wings 33 (see figure 4), liquid flows axially upwardly as illustrated by means of arrows in the figures 2 and 3. Centrally in the pumping member 17 there is left an air filled space which, if desired, may communicate with air surrounding the pumping member 17. For this purpose the pumping member 17 may carry a small pipe, which extends from the centre of the pumping member radially outwardly to the outside of the pumping member. A pipe of this kind is indicated by dotted lines in figure 2 at the upper part of the pumping member 17.

Liquid entering the inlet chamber 21 of the centrifugal rotor 10 through the pumping member 17 is conducted therefrom through the inlet channel 22 into the separation chamber 23. In this chamber there is arranged a set of conical separation discs, which between themselves form thin separation

spaces. In the separation spaces the small drops of oil suspended in the coolant are separated by being forced by the centrifugal force to move towards the rotational axis of the centrifugal rotor and out through the outlet 24. The coolant freed from oil first flows in a direction from the rotational axis of the centrifugal rotor out of said separation spaces and then through one or more collecting channels back towards the rotational axis to the centrifugal rotor outlet 25 for cleaned coolant.

Whereas separated oil is conducted through the outlet 26 in the casing 7 to a particular recipient therefore, the cleaned coolant is conducted through the outlet 27 back to the liquid body 4 in the container 1. Thus, the coolant is conducted from the outlet 27 to the return chamber 28 and from there through the pipe 16 out into the liquid body 4.

Since the amount of oil separated from the coolant is extremely small, there is returned to the liquid body 4 a flow of liquid which is substantially of the same magnitude as that passing via the floater 14 into the collecting container 11. A certain difference as to levels comes up between the liquid surfaces in the return chamber 28 and in the surrounding container 1, respectively, as illustrated in the figures 2 and 3.

As also illustrated in the figures 2 and 3, there are formed in the area of the floater 14 two particular liquid surfaces immediately inside and outside, respectively, the bellows 13. These liquid surfaces are formed because air has been enclosed on the underside of the floater both inside and outside the collecting container 11. It should be mentioned, that the overpressure coming up in the air thus trapped contributes to the floating ability of the floater.

As can be understood, the floater 14 adapts its position to the amount of liquid present in the container 1, whereas the bottom plate 12 is maintained at an unchanged level. Furthermore it can be understood, that the pumping capacity of the pumping member 17 is automatically increased, if the separation capacity of the centrifugal rotor is increased by increasing of its rotational speed. Upon such an increase of the pumping capacity the inflow of liquid into the collecting container 11 from the liquid body 4 automatically increases.

The collecting container 11 need not necessarily be carried by the casing 7, which surrounds the centrifugal rotor 10 and the pumping member 17. Alternatively, it may be supported by the container 1, e.g. stand on its bottom. Also, the stationary wall 19, which surrounds the pumping member 17 and supports part of the sealing device 20, need not be carried by the casing 7. Even the wall 19 may alternatively be carried by the container 1. However, the arrangement shown in the drawing is advantageous for several reasons. Thus, for the function of the sealing device 20 it is advantageous that both of the co-operating sealing members 29 and 32 are carried by one and the same suspension device. Since a suspension device for the rotatable centrifugal rotor 10 should be flexible and, thus, the rotatable part of the sealing device 20 becomes flexibly suspended, also the non-rotatable part of the sealing device should be flexibly suspended. Furthermore, since the non-rotatable wall 19 around the pumping member 17 is preferably flexibly suspended, it is also advantageous that the collecting container 11 is flexibly suspended from the same suspension advice. Thereby, for instance the wall 19 or other members connected therewith may be used for guiding the vertical movements of the floater 14. In the shown arrangement the wings 34 (see figure 5) are used for such guiding.

Claims

1. A method of removing from a liquid body (4) a liquid mixture, which forms a surface layer on the liquid body, and separating this liquid mixture into one relatively light liquid and one relatively heavy liquid, the liquid mixture being first caused to flow from the liquid body (4) over an overflow outlet member (14) into a collecting chamber (15) and then pumped therefrom into a centrifugal separator, characterised in that the liquid mixture is pumped from the collecting chamber (15) upwardly and into a rotating centrifugal rotor (10), included in said centrifugal separator, by means of a pumping member (17), which is connected with the centrifugal rotor (10) and is rotating therewith and extends down into the liquid mixture in the collecting chamber (15.

2. A method according to claim 1, in which the overflow outlet member (14) is kept floating on said liquid body (4) and/or the liquid mixture present in the collecting chamber (15).

3. A method according to claim 1 or 2, in which the overflow outlet member (14) is kept vertically movable relative to said pumping member (17) and the liquid mixture is caused to flow from the liquid body (4) into the collecting chamber (15) by the same flow as that by which liquid mixture is pumped by means of the pumping member (17) to the centrifugal rotor (10).

4. A method according to anyone of the claims 1 to 3, in which the liquid mixture is conducted into collecting chamber (15) around the whole circumference of the pumping member (17).

5. A method according to any one of the preceding claims, in which the liquid mixture is pumped upwardly through the rotating pumping member (17) from the collecting chamber (15) to the centrifugal rotor (10), while liquid mixture still in the collecting chamber (15) is kept separate from contact with the outside of at least part of the pumping member (17) by means of a sealing device (20).

6. A method according to any one of the preceding claims, in which relatively heavy liquid separated in the centrifugal rotor (10) is returned to said liquid body (4) at a level lower than said surface layer thereon.

7. A method according to claim 6, in which the separated heavy liquid is conducted back to the liquid body (4) via a passage (28, 16) extending through the collecting chamber (15).

8. A device for removing from a liquid body (4) a liquid mixture, which forms a surface layer on the liquid body, and separating this liquid mixture into one relatively light liquid and one relatively heavy liquid, said device including

- a vertically movable overflow outlet member (14) adapted to be overflowed by liquid mixture from the surface layer of said liquid body (4).

- a collecting container (11) adapted to receive liquid mixture having overflowed the overflow outlet member (14), and

- a centrifugal separator adapted to receive liquid mixture from the collecting container (11) and to separate it into said relatively light liquid and said relatively heavy liquid,

characterised in

- that the centrifugal separator includes a centrifugal rotor (10), which is connected with a pumping device adapted to extend from above and down into liquid mixture present in said collecting container (11),

- that the centrifugal separator further includes a driving device, which is adapted to drive the centrifugal rotor (10) as well as the pumping device connected therewith, and

- that the pumping device is adapted to pump liquid mixture to and into the centrifugal rotor (10).

9. A device according to claim 8, in which the pumping device includes a pumping member (17), which is connected with the centrifugal rotor (10) and rotatable therewith around a rotational axis R common for the pumping member and the centrifugal rotor.

10. A device according to claim 9, in which the pumping member (17) is tubular and has a central pumping channel for pumping of liquid mixture from the collecting container (11) to the centrifugal rotor (10).

11. A device according to claim 9 or 10, in which the centrifugal rotor (10) and the pumping member (17) are rotatable around a substantially vertical rotational axis R.

12. A device according to any one of the claims 9-11, in which the pumping member (17) is surrounded by a non-rotatable wall (19), which is adapted to extend from above and down into liquid mixture present in the collecting container (11) and a sealing device (20) is adapted to seal

between the non-rotatable wall (19) and the rotatable pumping member (17), so that liquid mixture is prevented from moving upwardly on the outside of the pumping member (17) as a consequence of the rotation thereof.

13. A device according to claim 12, in which the centrifugal rotor (10) is suspended from a flexible suspension device (8) and the non-rotatable wall (19) is suspended from the same flexible suspension device (8) for avoiding relative pendulum movements between the non-rotatable wall (19) and the rotatable pumping member (17) during operation of the centrifugal rotor (10).

14. A device according to claim 12 or 13, in which the sealing device (20) comprises an annular axially movable sealing member (29) and means (30) adapted to accomplish an axial sealing force between the non-rotatable wall (19) and the rotatable pumping member (17).

15. A device according to claim 14, in which the annular sealing member (29) is non-rotatable and adapted to be pressed axially against the rotatable pumping member (17).

16. A device according to claim 15, in which the pumping member (17) is tubular and the non-rotatable sealing member (29) is adapted to be pressed against an end surface of the rotatable pumping member (17).

17. A device according to any one of the claims 12-16, in which the collecting container (11) is suspended from the non-rotatable wall (19).

18. A device according to claim 17, in which the centrifugal rotor (10) is surrounded by a casing (7), which delimits spaces (27) for receiving

separated relatively heavy liquid and conducting it via a passage (28, 16) extending through the collecting container (11) to said liquid body (4).

19. A device according to any one of the claims 8-18, in which members (31), e.g. wings, are arranged in the collecting container (11) for counteracting liquid rotation therein.

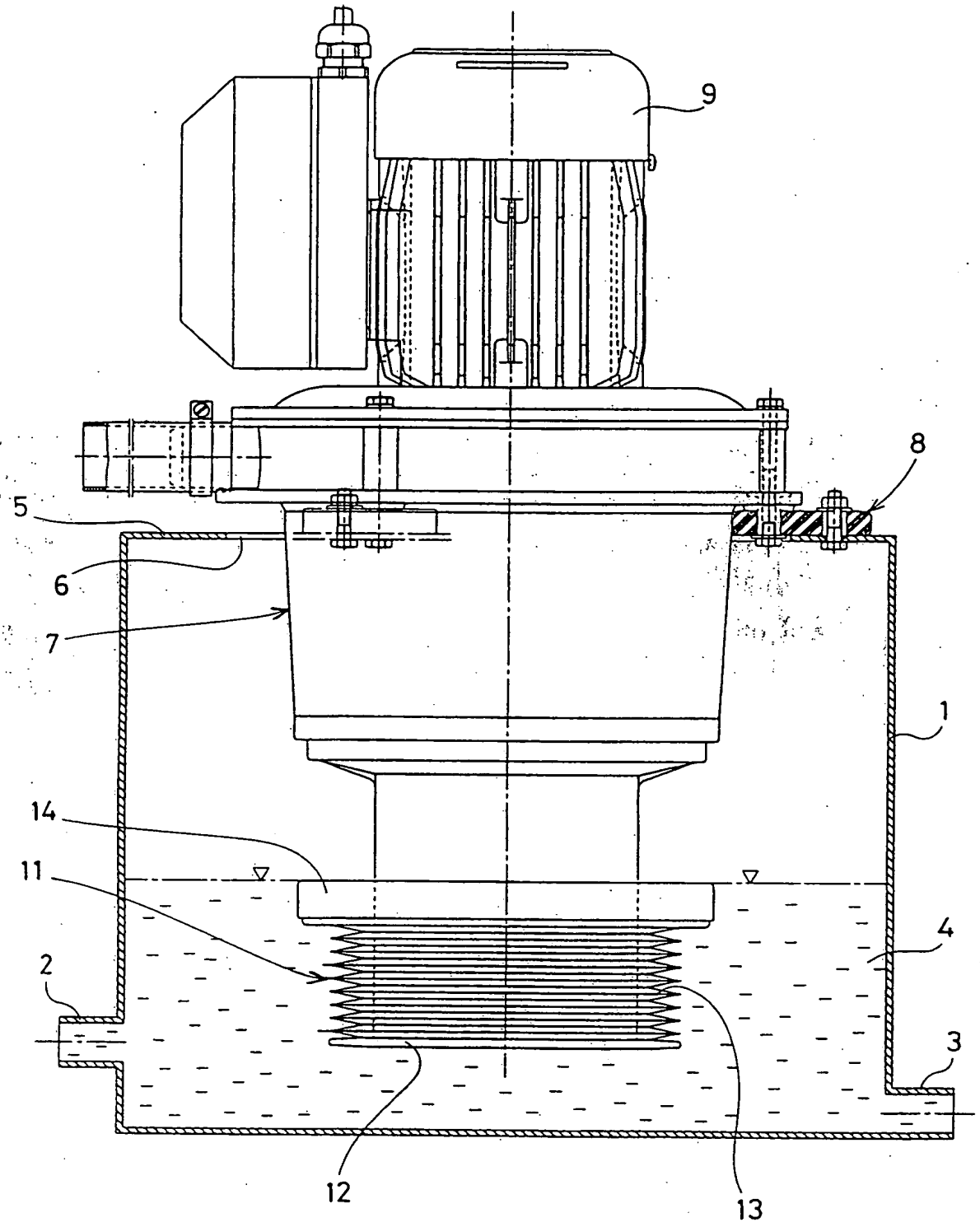

Fig.1

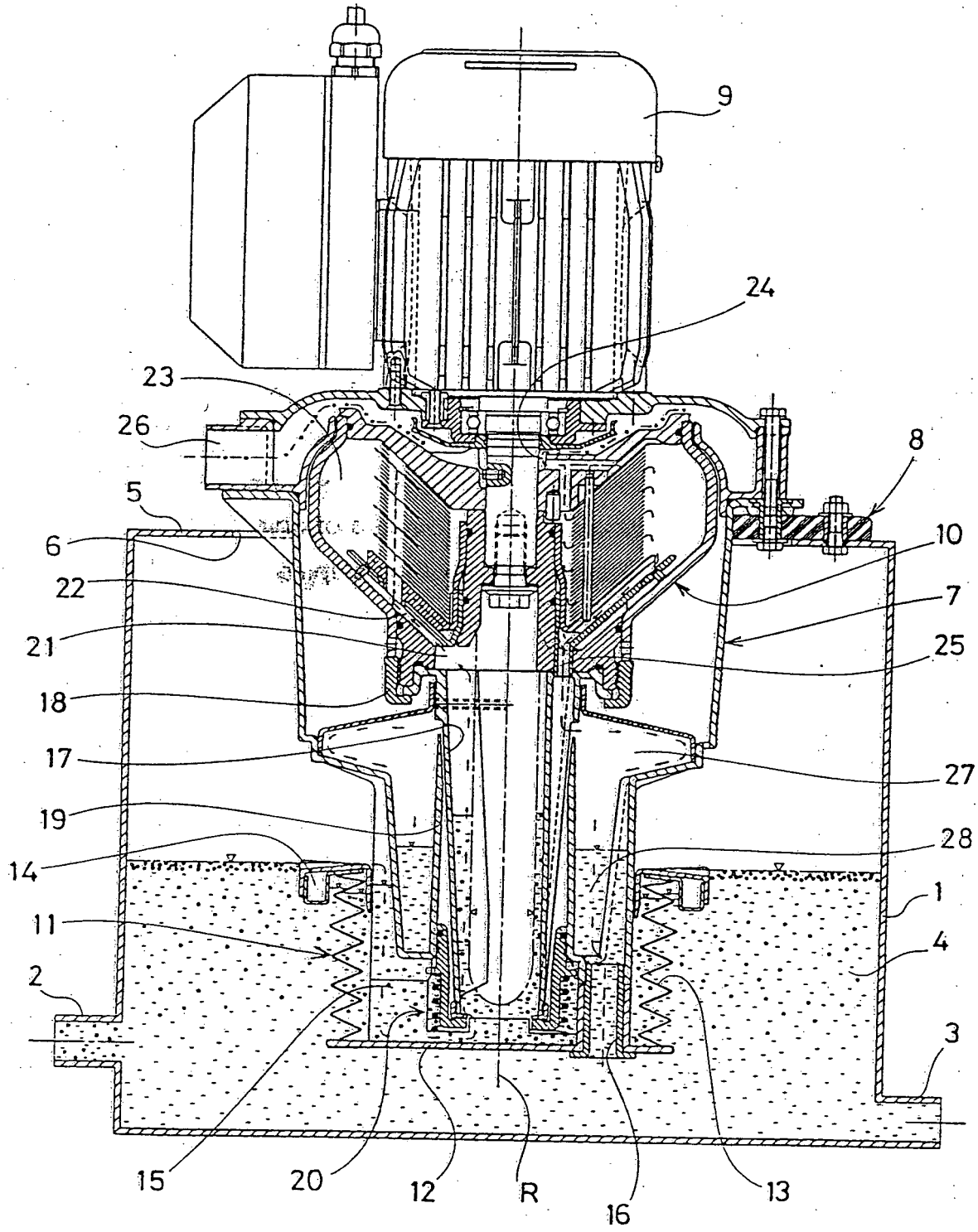

Fig.2

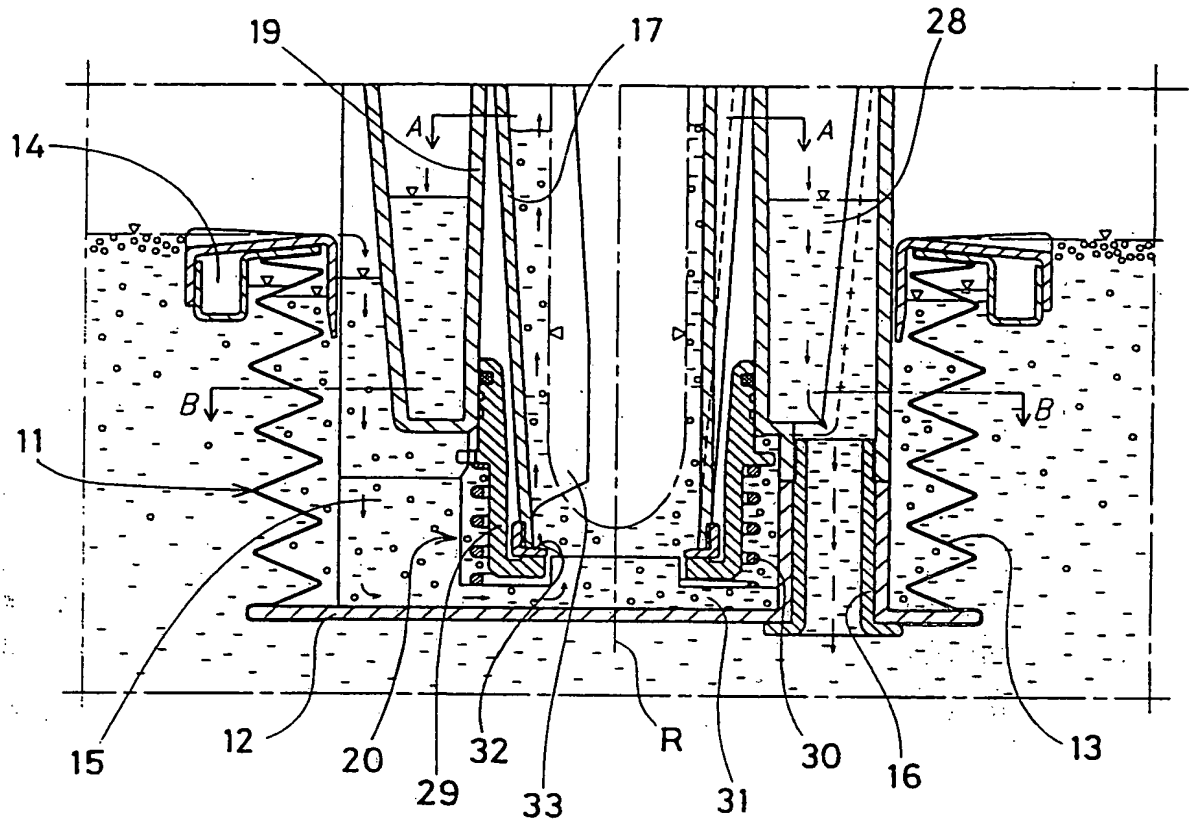

Fig.3

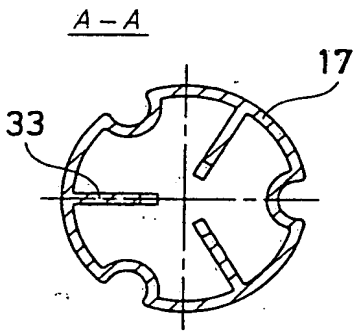

Fig.4

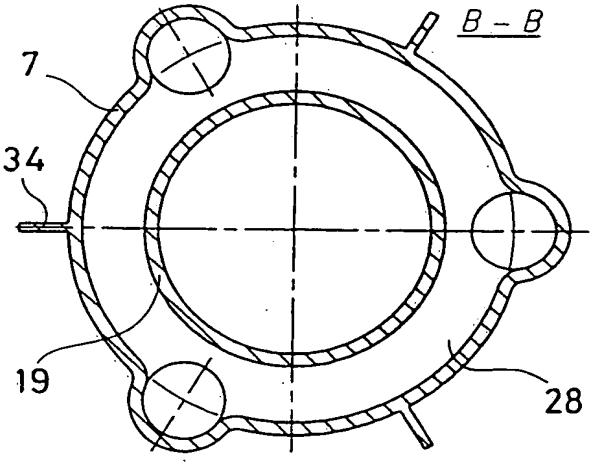

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00551

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B04B 11/02 // B23Q 11/10, F04D 1/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B04B, B23Q, F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SE 78495 C (R.M. WENDEL), 3 November 1927 (03.11.27), figures 1,2	1
A	EP 0164866 A1 (ALFA-LAVAL SEPARATION AB), 18 December 1985 (18.12.85), figures 1,2	1
A	US 3633749 A (R.L. PANOSH), 11 January 1972 (11.01.72), figure 1	1
A	US 5693218 A (H. YAMAMOTO ET AL), 2 December 1997 (02.12.97), abstract	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 June 2000	25 -07- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lena Nilsson / MRo Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 00/00551

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CA 1252076 A	04/04/89
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